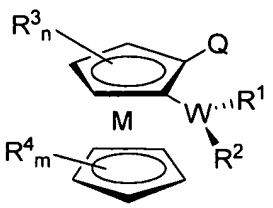
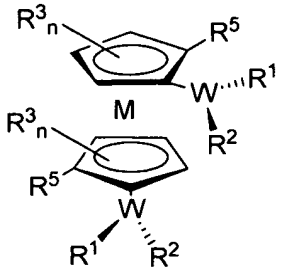
## AMENDMENTS TO THE CLAIMS

1–22. (Canceled)

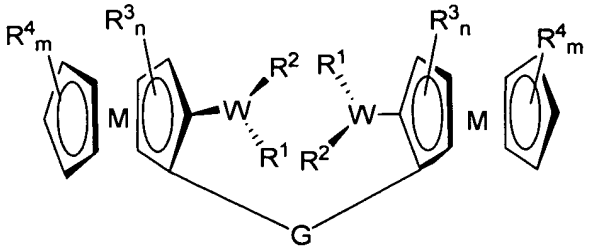
23. (New) A metallocene–based ligand having a formula selected from the group consisting of Formula (I), Formula (II), Formula (III), Formula (IV), Formula (V), Formula (VI), Formula (VII), Formula (VIII), and Formula (IX):



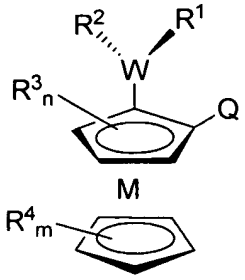
Formula (I)



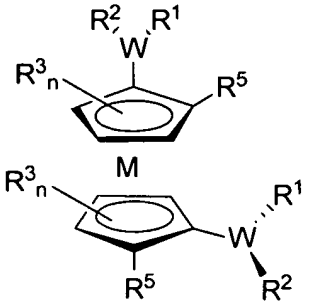
Formula (II)



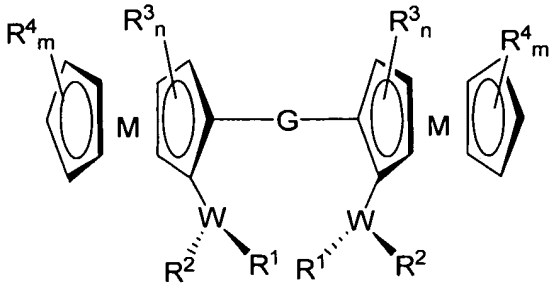
Formula (III)



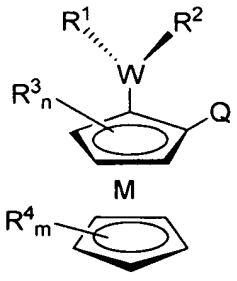
Formula (IV)



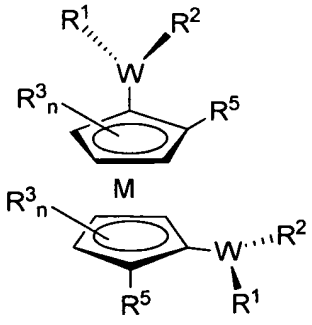
Formula (V)



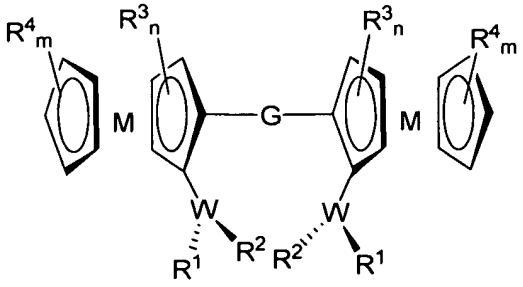
Formula (VI)



Formula (VII)



Formula (VIII)



Formula (IX)

wherein W is phosphorus or arsenic;

M is a metal;

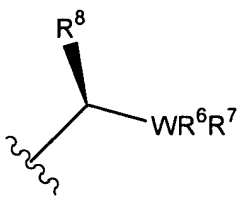
$R^1$ and $R^2$ are different from each other and are independently selected from the group consisting of unsubstituted branched–chain alkyl, unsubstituted straight–chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, unsubstituted heteroarylamino, unsubstituted branched–chain alkyl, unsubstituted straight–chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, and unsubstituted heteroarylamino;

$R^3$ and $R^4$ are independently selected from the group consisting of substituted branched–chain alkyl, substituted straight–chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched–chain alkyl, unsubstituted straight–chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl;

n is an integer of from 0 to 3;

m is an integer of from 0 to 5;

Q is selected from the group consisting of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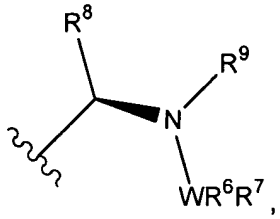
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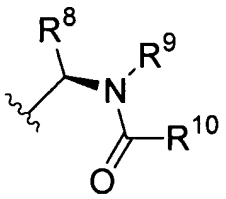
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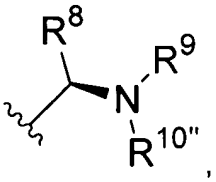
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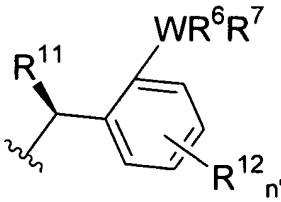
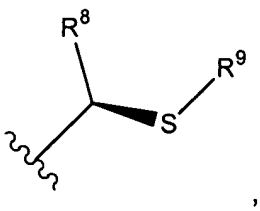
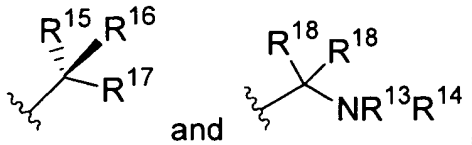

, and

,

wherein $R^6$ and $R^7$ are independently selected from the group consisting of substituted branched–chain alkyl, substituted straight–chain alkyl, substituted

alkoxy, substituted alkylamino, substituted cycloalkyl, substituted cycloalkoxy, substituted cycloalkylamino, substituted carbocyclic aryl, substituted carbocyclic aryloxy, substituted heteroaryl, substituted heteroaryloxy, substituted carbocyclic arylamino, substituted heteroarylamino, unsubstituted branched–chain alkyl, unsubstituted straight–chain alkyl, unsubstituted alkoxy, unsubstituted alkylamino, unsubstituted cycloalkyl, unsubstituted cycloalkoxy, unsubstituted cycloalkylamino, unsubstituted carbocyclic aryl, unsubstituted carbocyclic aryloxy, unsubstituted heteroaryl, unsubstituted heteroaryloxy, unsubstituted carbocyclic arylamino, and unsubstituted heteroarylamino; $R^8$, $R^9$, $R^{10}$, and $R^{10"}$ are independently selected from the group consisting of hydrogen, substituted branched–chain alkyl, unsubstituted branched–chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; $R^{11}$ is selected from the group consisting of $OR^{13}$, $SR^{13}$, $NHR^{13}$, and $NR^{13}R^{14}$, wherein $R^{13}$ and $R^{14}$ are independently selected from selected from the group consisting of hydrogen, substituted branched–chain alkyl, unsubstituted branched–chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; $R^{12}$ is selected from the group consisting of hydrogen, halogen, $OR^{13}$, $SR^{13}$, $NR^{13}R^{14}$, substituted branched–chain alkyl, unsubstituted branched–chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl, and n' is 0 to 4;

$R^5$ is selected from the group consisting of

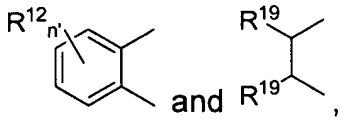



and ,

wherein $R^{15}$, $R^{16}$ and $R^{17}$ are independently selected from the group consisting of hydrogen, halogen, $OR^{13}$, $SR^{13}$, $NR^{13}R^{14}$, substituted branched–chain alkyl, unsubstituted branched–chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; and wherein the two

geminal substituents $R^{18}$ together are a doubly bonded oxygen atom, or each geminal substituent $R^{18}$ is individually hydrogen; and

G is selected from the group consisting of –C(=O)NH–R*–NHCO–, –C(=O)–OR*O–C(=O)–, –C(=O)–R*C(=O)–, –CH=N–R*–N=CH–, $–CH_2NH–R*–NHCH_2–$, $–CH_2NHC(=O)–R*–C(=O)NHCH_2–$, $–CH(R^8)NH–R*–NH(CH(R^8)–$, $–CH(R^8)NHC(=O)–R*–C(=O)NHCH(R^8)–$, –C(=O)NH–R–NHC(=O)–, –C(=O)–ORO–C(=O)–, –C(=O)–RC(=O)–, –CH=N–R–N=CH–, $–CH_2NH–R–NHCH_2–$, $–CH_2NHC(=O)–R–C(=O)NHCH_2–$, $–CH(R^8)NH–R–NH(CH(R^8)–$, $–CH(R^8)NHC(=O)–R–C(=O)NHCH(R^8)–$; wherein –R*– and –R– are selected from the group consisting of:



and ,

wherein the two substituents $R^{19}$ together are $–(CH_2)_{m'}–$ or each substituent $R^{18}$ is independently selected from the group consisting of hydrogen, substituted branched–chain alkyl, unsubstituted branched–chain alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, substituted carbocyclic aryl, unsubstituted carbocyclic aryl, substituted heteroaryl, and unsubstituted heteroaryl; n' is an integer of from 0 to 4; and m' is an integer of from 1 to 8.

24. (New) The metallocene–based ligand of Claim 1, which is an enantiomer having Formula (IV), Formula (V), or Formula (VI).

25. (New) The metallocene–based ligand of Claim 1, which is a diastereomer having Formula (VII), Formula (VIII), or Formula (IX).

26. (New) The metallocene–based ligand of Claim 1, wherein the metallocene-based ligand is a phosphine or arsine having chirality at W, and wherein the metallocene–based ligand has at least one additional element of chirality selected from the group consisting of planar chirality, chirality at carbon, and axial chirality.

27. (New) The metallocene–based ligand of Claim 1, wherein the metallocene-based ligand is a diphosphine or diarsine having chirality at W, and wherein the metallocene–based ligand has two additional elements of chirality comprising planar chirality and chirality at carbon.

28. (New) The metallocene–based ligand of Claim 1, wherein the metallocene-based ligand is a diphosphine or diarsine having chirality at W, and wherein the metallocene–based ligand has three additional elements of chirality comprising planar chirality, chirality at carbon, and axial chirality.

29. (New) The metallocene–based ligand of Claim 1, wherein the metallocene is ferrocene.

30. (New) The metallocene–based ligand of Claim 1, wherein W is phosphorus.

31. (New) A catalyst or catalyst precursor in an asymmetric transformation reaction to generate a high enantiomeric excess of a formed compound, the catalyst or catalyst precursor comprising the metallocene–based ligand of Claim 1.

32. (New) A transition metal complex containing a transition metal coordinated to the metallocene–based ligand of Claim 1.

33. (New) A transition metal complex according to Claim 32, wherein the transition metal is a Group VIb metal or a Group VIII metal.

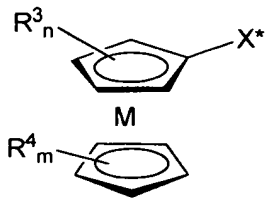
34. (New) A method for preparing the metallocene–based ligand, comprising:

providing a metallocene–based substrate having a chiral directing substituent on one or both rings;

ortho-litiating the metallocene–based substrate; and

converting the ortho–lithiated metallocene–based substrate to obtain the metallocene–based ligand of Claim 1.

35. (New) The method according to Claim 34 wherein the metallocene–based ligand has Formula (I) or Formula (III), wherein the metallocene-based substrate having Formula (X'):

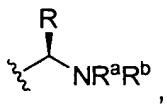
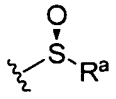
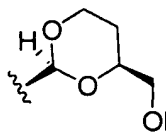
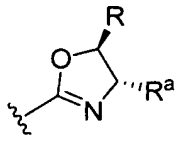
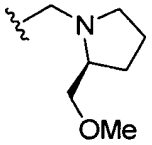
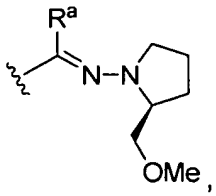
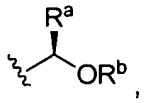
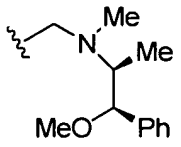
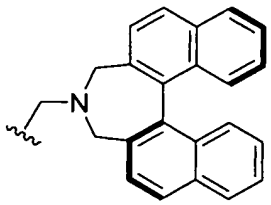



Formula (X')

wherein $R^3$, $R^4$, and n are as defined in Claim 1, and wherein X* is a chiral directing group, wherein the step of converting the ortho–lithiated metallocene–based substrate

comprises reacting the ortho–lithiated metallocene–based substrate with an $R^1$ substituted phosphine or an $R^1$ substituted arsine, and with an $R^2$–bearing Grignard reagent or an $R^2$–bearing organolithium compound, then converting X* to Q or G.

36. (New) The method according to Claim 35, wherein X* is selected from the group consisting of:

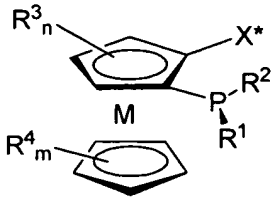










, wherein $R^a$ and $R^b$ are independently selected from the group consisting of substituted branched–chain alkyl, substituted straight–chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched–chain alkyl, unsubstituted straight–chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl.

37. (New) The method according to Claim 35, wherein the ortho–lithiating step is conducted using at least one lithiating agent selected from the group consisting of n–butyllithium, sec–butyllithium, and tert–butyllithium.

38. (New) The method according to Claim 37, wherein the step of converting the ortho–lithiated metallocene–based substrate comprises reacting the ortho–lithiated metallocene–based substrate *in situ* with a dichlorophosphine of the formula $R^1PCl_2$ wherein $R^1$ is as defined in Claim 1, to yield an intermediate product, wherein the intermediate product is converted to obtain the metallocene–based ligand of Claim 1.

39. (New) The method according to Claim 38, further comprising reacting the intermediate product with an organometallic reagent of formula $R^2Z$, wherein $R^2$ is as defined in Claim 1, wherein Z is Li or MgY, and wherein Y is a halide, to obtain a phosphorus chiral compound having Formula (XI'):



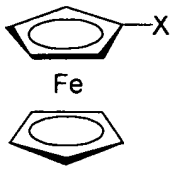

Formula (XI')

wherein the phosphorus chiral compound is converted to obtain the metallocene–based ligand of Claim 1.

40. (New) The method of Claim 39, wherein the metallocene–based ligand has Formula (I) or Formula (III).

41. (New) A method for preparing a metallocene–based ligand of Claim 1, comprising:

providing a compound of Formula (XXXVII):

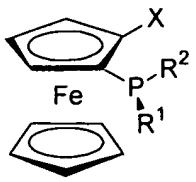



(XXXVII)

wherein X is an achiral directing group;

subjecting the compound of Formula (XXXVII) to enantioselective mono–ortho–lithiation using at least one lithiating agent selected from the group consisting of n–butyllithium, sec–butyllithium, and tert–butyllithium, wherein the mono-ortho-lithiation is conducted in the presence of a homochiral tertiary amine, whereby a chiral monolithium compound is obtained;

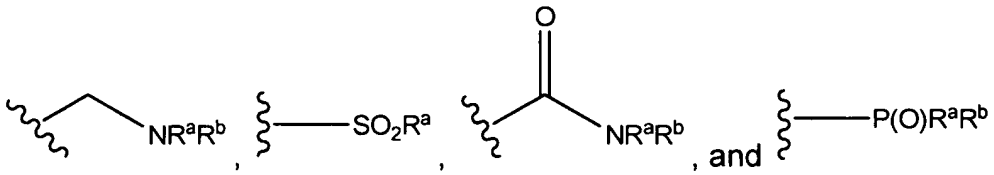
reacting the chiral monolithium compound *in situ* with a dichlorophosphine of the formula $R^1PCl_2$ followed by reacting with an organometallic reagent of the formula $R^2Z$, wherein $R^1$ and $R^2$ are as defined in Claim 1, wherein Z is Li or MgY, and wherein Y is a halide, to obtain a phosphorus chiral compound having Formula (XXXVIII):




(XXXVIII)

and converting the phosphorus chiral compound having Formula (XXXVIII) to the metallocene–based ligand of Claim 1, wherein the metallocene–based ligand has Formula (I) or Formula (III).

42. (New) The method according to Claim 41 wherein X is selected from the group consisting of:

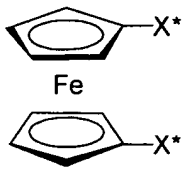



, and

wherein $R^a$ and $R^b$ are independently selected from the group consisting of substituted branched–chain alkyl, substituted straight–chain alkyl, substituted cycloalkyl, substituted carbocyclic aryl, substituted heteroaryl, unsubstituted branched–chain alkyl, unsubstituted straight–chain alkyl, unsubstituted cycloalkyl, unsubstituted carbocyclic aryl, and unsubstituted heteroaryl.

43. (New) A method for preparing a metallocene–based ligand of Claim 1, comprising:

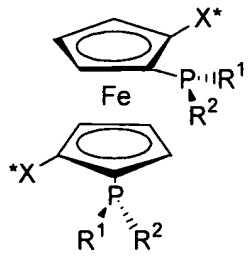
providing a compound of Formula (XXXIX):




(XXXIX)

wherein X* is a chiral directing group;

subjecting the compound of Formula (XXXIX) to bis–ortho–lithiation using at least one lithiating agent selected from the group consisting of n–butyllithium, sec–butyllithium, and tert– butyllithium, whereby a bislithium compound is obtained; reacting the resulting bislithium compound *in situ* with a dichlorophosphine of the formula $R^1PCl_2$ followed by reacting with an organometallic reagent of the formula $R^2Z$ wherein $R^1$ and $R^2$ are as defined in Claim 1w wherein Z is Li or MgY, and wherein Y is a halide, to obtain a phosphorus chiral compound having Formula (XXXX):




(XXXX)

and converting the phosphorus chiral compound having Formula (XXXX) to the metallocene–based ligand of Claim 1, wherein the metallocene–based ligand has Formula (II).